SUDETES 2003 SEISMIC EXPERIMENT

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1. INTRODUCTION

SUDETES 2003 is latest of a series of large 3-D refraction seismic experiments in Central Europe. It fills the gap between the regions covered by the previous experiments, POLONAISE'97, CELEBRATION 2000 and ALP 2002. These experiments are described in papers by *Gutercht et al. (2003a,b)*, *Brueckl et al. (2003)* and *Plomerová et al. (2003)*. Specifically, SUDETES 2003 covered mainly the northern part of the Bohemian Massif and some of the neighboring Polish basin to the northeast and the West Carpathians to the East.

The Bohemian Massif is the easternmost outcropping part of the Late Paleozoic Variscan Orogen in Europe. Its geological history is presented for example in a volume edited by *Suk (1984)*; its geophysical characteristics are presented in *Bucha and Blížkovský (1994)*, and detailed studies of the western portion of the massif are discussed in *Vrána and Štědrá (1998)*. Specific geologic targets of the *SUDETES 2003* experiment include:

- Characteristics of crustal-scale fault zones parallel and normal to the Trans-European Suture Zone in Central Europe (Silesia-Northern Bohemia regions);
- Recognition of changes in crustal structure across these major fault zones;
- Identification of boundaries of individual terranes forming the Armorican terrane assemblage in Central Europe
- Identification of lithospheric architecture over areas of Cenozoic tectonothermal activity.

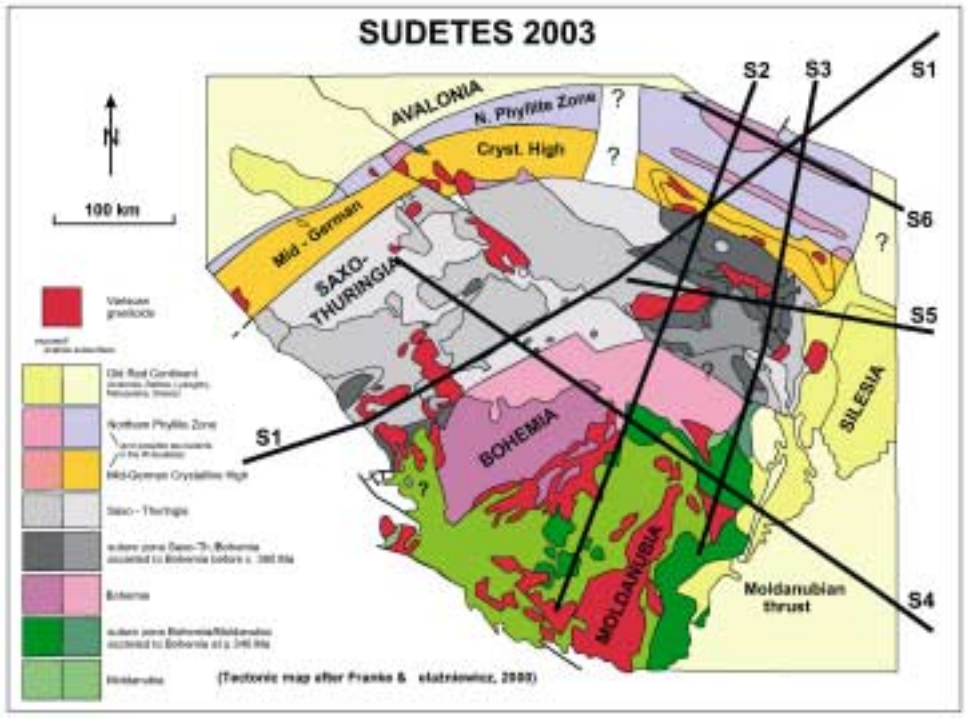

Fig. 1. Tectonic map of the Bohemian Massif (*Franke and Żelaźniewicz, 2000*) and main profiles S1-S6 made during SUDETES 2003 seismic experiment.

Individual profiles of the SUDETES 2003 experiment (Figures 1 and 2) should help to solve the problems listed above and contribute to better understanding of the following structures and tectonic features:

Profile S1 is oriented along the Eger Graben and profile S4 is almost perpendicular to it. The Eger Graben, oriented approximately in a SW-NE direction and intersecting the Elbe Zone structures in the region of North Bohemia (Figure 1) is a Neogene rift, characterized by significant Oligo-Miocene volcanism. At the deep crustal level, the rift axis is generally associated with the SE-inclined boundary of the Saxothuringian and Moldanubian terranes (Figure 1), originated as one of major subduction zones within the Variscan belt during the Middle-Late Paleozoic (e.g., *Dallmeyer et al., 1995*). The actual spatial characteristics of this boundary, its interference with the intersecting Elbe zone structures, as well as the history of its numerous reactivations at shallow crustal levels, also remain challenges to our understanding of the geodynamic history of Central Europe.

Profiles S5 and S6 are oriented along significant fault zones and structures parallel to the Trans-European Suture Zone (TESZ);

Profiles S2 and S3 are perpendicular to them. The TESZ region is a boundary between lithospheric domains with different geodynamic history, composition, and geophysical

properties (e.g., *Thybo et al., 1999, 2002*; *Bogdanova et al., 2001*; *Guterch et al., 1999*; *Grad et al., 1999, 2002*; *EUROBRIDGE Working Group, 1999*). The area covered by the above mentioned profile arrangement is limited to the northeast by the Dolsk Fault Zone. This fault zone, closest to the TESZ situated further to the northeast, was recognized by LT-7 profile (*Guterch et al., 1994*) and the POLONAISE'97 seismic refraction experiment as a boundary between the thinned crust of Baltica and the West Gondwana derived terranes of East Avalonia and of the Armorican assemblage (*Jensen et al., 1999*; *Grad et al., 2002*). Characteristics and processes bringing about other fault zones in the region in question still need closer studies. The Odra Fault Zone active in Permo-Mesozoic through Cenozoic times as crustal weakness with varying senses of movement, is suspected to be related to the eastern continuation of the Mid-German Crystalline Rise – a Carboniferous magmatic arc at the edge of the Saxothuringian terrane. Its duration and significance is comparable with those of the Elbe Fault Zone. The NW-SE oriented Elbe Zone (covering, in broad definition, an area between Prague and the Czech/Polish border), has for most of its history been active as an important strike-slip zone parallel to the Tornquist-Teisseyre Zone.

Fig. 2. SUDETES 2003 experiment map showing location of profiles (solid and dashed lines) and shot points (starts). Red star shows location of shot point 4–115–0 for which record sections along profiles S1, S3 and S6 are shown in Figure 3.

2. DESCRIPTION OF THE PROJECT

The SUDETES 2003 experiment employed an up-to-date, 3-D implementation of the seismic refraction method. The layout of the field part of the project consists of network of recording profiles where not only in-line shots but also off-line ones (particularly in SW Poland) were fired to obtain dense ray coverage for 3-D modeling (Figure 2). The experiment was comprised of 6 high-density (S1-S6) and 4 low-density profiles with total length of 3450 km and stations spacing 3 – 4 km or ~ 6 km. All together 53 shots were fired along most of the recording profiles with the charge ranging from 50 to 1000 kg (see Table 1).

Table 1. Details of the explosive sources used in the *SUDETES 2003* experiment.

Shot number	Longitude deg E	Latitude deg N	Date [yyyy.mm.dd]	Time UTC [hh:mm:ss.sss]	Charge [kg]
41010	11.239200	49.654200	2003.06.05	06:00:56.485	1400
41020	12.078970	49.850670	2003.06.04	17:11:25.649	1000
41021	12.080360	49.850640	2003.06.05	14:27:00.000	935
41040	12.542615	49.977600	2003.06.04	19:09:59.526	200
41050	12.222886	50.119815	2003.06.04	17:09:59.525	400
41060	12.776166	50.113666	2003.06.04	18:09:59.476	400
41061	12.908558	50.020931	2003.06.05	19:09:59.569	400
41070	12.983333	50.133000	2003.06.04	20:09:59.311	400
41080	12.668401	50.261005	2003.06.05	21:09:59.546	400
41090	13.278666	50.356166	2003.06.04	22:09:59.575	400
41100	14.065166	50.579333	2003.06.04	23:09:59.329	2600
41110	14.396391	50.707368	2003.06.06	00:09:59.789	400
41120	15.133666	50.942750	2003.06.05	01:09:59.328	400
41130	15.491969	51.155583	2003.06.04	22:20:00.000	100
41140	16.034777	51.392980	2003..06.05	22:20:00.000	250
41150	16.907244	51.743350	2003.06.06	02:10:00.000	150
41160	18.584100	52.479008	2003.06.06	22:50:00.000	250
42010	14.481666	48.726500	2003.06.04	17:30:10.298	400
42020	14.920666	49.252333	2003.06.05	03:30:01.235	400
42030	14.949806	49.504791	2003.06.05	03:20:00.603	400
42050	15.557000	50.554666	2003.06.05	17:30:00.635	400
42070	15.601655	50.903508	2003.06.05	02:10:00.000	50
42080	16.397602	51.963022	2003.06.04	22:40:00.000	250
43010	15.913583	49.080750	2003.06.06	17:29:59.960	400
43020	16.177581	49.794503	2003.06.06	03:40:00.613	400
43040	16.288770	50.078970	2003.06.05	03:40:01.274	400
43060	16.617047	50.524627	2003.06.04	22:30:00.000	50
43070	16.707269	50.775958	2003.06.05	00:40:00.000	150
43080	16.811491	51.295363	2003.06.05	22:30:00.000	250
44010	12.762560	51.022500	2003.06.06	08:01:00.000	30
44020	12.836900	20.945500	2003.06.06	16:01:00.000	1000
44030	13.143900	50.829500	2003.06.06	12:16:22.680 (?)	425
44031	13.143000	50.829000	2003.06.06	12:25:22.929 (?)	2930

44040	13.635666	50.697000	2003.06.04	19:00:00.624	400
44050	13.687163	50.548466	2003.06.04	18:49:59.990	400
44060	14.282000	50.378666	2003.06.04	19:20:00.689	400
44070	14.428166	50.234000	2003.06.05	03:50:00.029	260
44080	15.079601	49.998864	2003.06.05	18:09:59.513	400
44090	15.760150	49.734280	2003.06.04	17:50:01.843	400
44100	16.165500	49.463500	2003.06.06	03:11:15.778	400
44110	16.744416	49.266916	2003.06.06	03:50:01.183	400
44140	18.704250	48.474333	2003.06.07	04:30:00.119	400
44170	19.507500	47.916400	2003.06.06	01:20:00.000	350
44180	19.645800	47.849700	2003.06.06	02:20:00.000	60
44190	19.796100	47.780600	2003.06.07	01:20:00.000	60
44200	19.915500	47.714700	2003.06.07	02:20:00.000	60
44210	20.834400	47.301900	2003.06.05	01:40:00.000	700
45010	17.514211	50.650294	2003.06.05	22:50:00.000	250
45020	18.215325	50.581300	2003.06.05	22:40:00.000	150
45030	19.305741	50.458080	2003.06.06	22:40:00.000	150
45040	20.144586	50.294294	2003.06.04	22:50:00.000	100
46010	15.718813	52.188958	2003.06.06	22:30:00.000	250
46020	18.020575	51.455991	2003.06.06	22:20:00.000	250

2.1 Seismic Recording Systems

As with CELEBRATION 2000 and ALP 2002, the main seismic recording system employed was the single-channel RefTek 125 ('Texan') recorder. The technical description of these instruments is available in the accompanying paper on the CELEBRATION 2000 experiment (*Guterch et al., 2003b*).

The total 920 'Texan' instruments available for SUDETES 2003 were as follows: Austria – 30, Finland – 15, Poland – 30, Germany – 25 and USA – 820. They were programmed with long continuous windows to increase the possibility of recording an earthquake. The total length of these recording windows was approximately 30 hours. The sample rate was 100 Hz (10 ms).

In addition to the 'Texan' instruments, some other 3-component instruments were employed in SW Poland as follows: MK-4P – 24 recording units (made in Poland) and RefTek 72A – 12 recording units (from Finland), all with Mark Products L-4-3D, 1 Hz seismometers.

2.2 Shooting Procedures

Although there were considerable variations due to local conditions and national procedures (Table 1), the standard shooting configuration was to drill 5-10 boreholes to a depth ~ 30 – 40 m and place ~ 30 – 50 kg of explosives in each hole. All shots in Poland were fired by a GPS-controlled blasting device. For the others, the instant was provided by placing a 'Texan' seismic recorder and geophone at a horizontal distance of 20 m from the nearest borehole.

2.3 Data Processing

All raw data from the 'Texan' – recordings are saved on several hard disks and tapes. The raw data of all shots and from the 'Texan' recorders were converted to SEGY and distributed less than a week after the field experiment ended. Geometry was added later. Samples of recordings, demonstrating the quality of the data are shown on Figure 3 for shot 4–115–0 recorded along three profiles S1, S3 and S6 in SW Poland. The sections show azimuthal differentiation in observed wave field, particularly for Pg and PmP waves. These observations, as well as first observations for other shot points, show that the crustal structure of the region of SUDETES 2003 experiment varies in a complex fashion that would be expected, given the region's tectonic history. The 3-D model that will ultimately be produced from these data, but also from previous POLONAISE'97, CELEBRATION 2000 and ALP 2003 experiments, should produce an intriguing image of the crustal scale structure. Well recorded waves till distance ca. 300 km from the shot points should provide new information about structure below the Moho discontinuity, down to ca. 60 – 80 km deep to the uppermost mantle.

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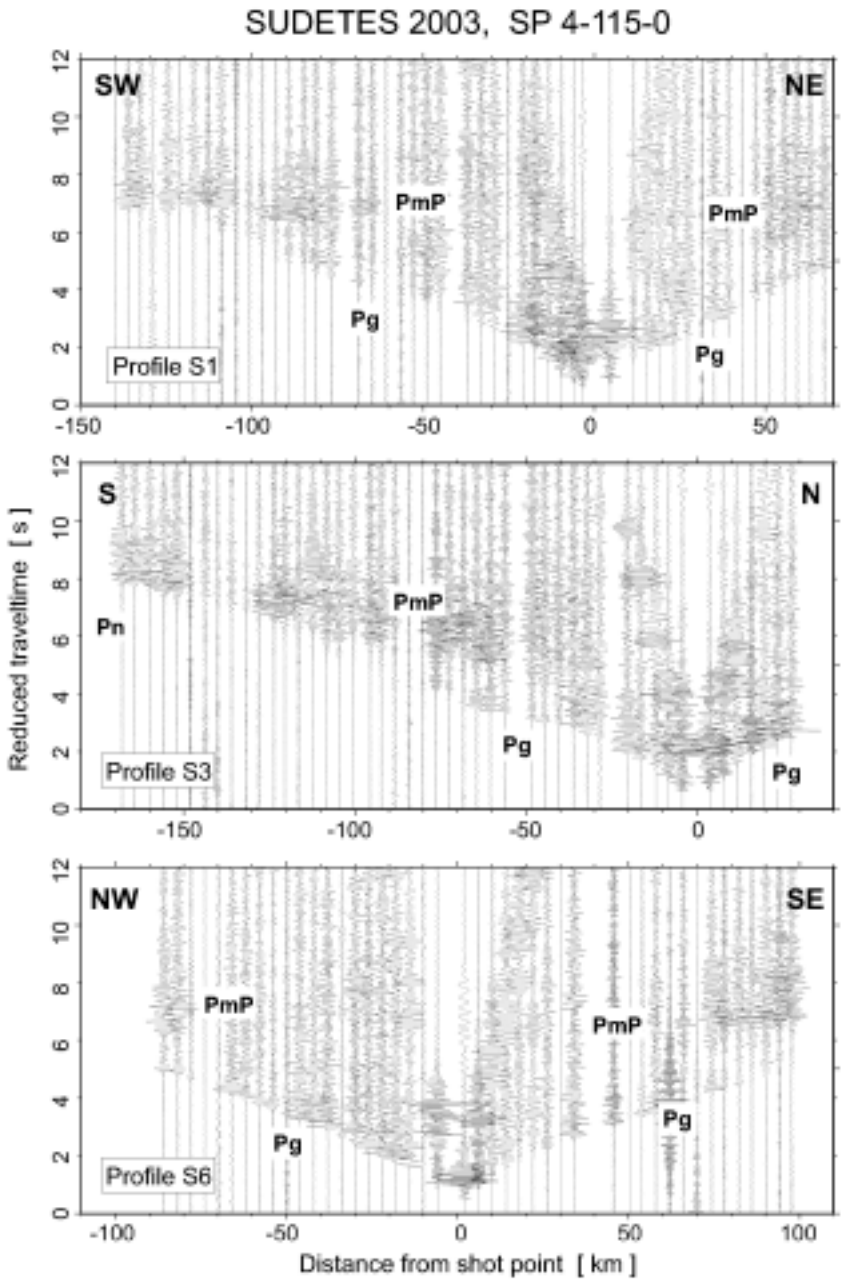

Fig. 3. Record sections for shot point 4–115–0 along profiles S1 (top), S3 (middle) and S6 (bottom). Pg are refracted waves in the crust; PmP and Pn are reflected and refracted waves from the Moho. For location see Figure 2.

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